AD-A053 650 TRAINING ANALYSIS AND EVALUATION GROUP (NAVY) ORLANDO FLA F/G 5/9
UTILIZATION OF DEVICE 2F87F OFT TO ACHIEVE FLIGHT HOUR REDUCTIO--ETC(U)
APR 78 R F BROWNING, L E RYAN, P G SCOTT

UNCLASSIFIED TAEG-54 NL

1 OF 1
AD
A053650

TAEG

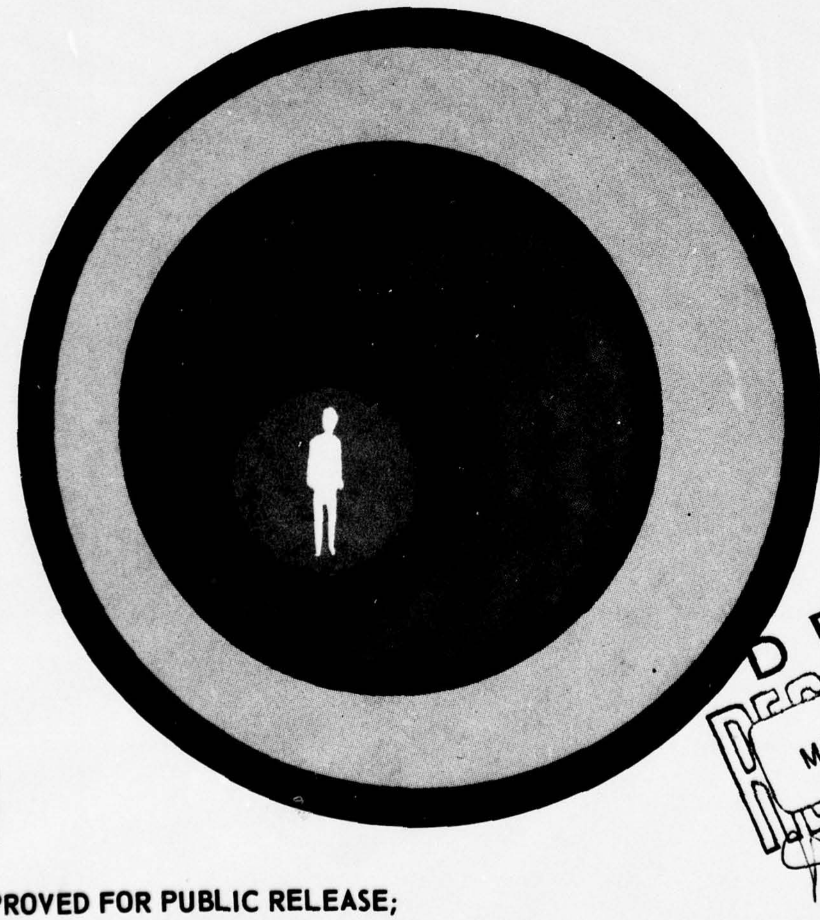
END
DATE
FILMED
6-78
DDC

TAEG

TRAINING
ANALYSIS
AND
EVALUATION
GROUP

12

TAEG REPORT NO. 54	UTILIZATION OF DEVICE 2F87F OFT TO ACHIEVE FLIGHT HOUR REDUCTIONS IN P-3 FLEET REPLACEMENT PILOT TRAINING



FOCUS
ON
THE
TRAINED
MAN

APPROVED FOR PUBLIC RELEASE;
DISTRIBUTION IS UNLIMITED.

APRIL 1978

TRAINING ANALYSIS AND EVALUATION GROUP

ORLANDO, FLORIDA 32813

(12)

TAEG Report No. 54

UTILIZATION OF DEVICE 2F87F OFT TO ACHIEVE FLIGHT HOUR REDUCTIONS IN P-3 FLEET REPLACEMENT PILOT TRAINING

Robert F. Browning
Leonard E. Ryan
Paul G. Scott

Training Analysis and Evaluation Group

April 1978

Alfred F. Smode

ALFRED F. SMODE, Ph.D., Director,
Training Analysis and Evaluation Group

Worth Scanland

WORTH SCANLAND, Ph.D.
Assistant Chief of Staff for
Research and Program Development
Chief of Naval Education and Training

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER 14 TAEG [redacted]-54	2. GOVT ACCESSION NO.	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) 6 UTILIZATION OF DEVICE 2F87F OFT TO ACHIEVE FLIGHT HOUR REDUCTIONS IN P-3 FLEET REPLACEMENT PILOT TRAINING,		5. TYPE OF REPORT & PERIOD COVERED 6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) 14 Robert F. Browning, Leonard E. Ryan [redacted] Paul G. Scott		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS Training Analysis and Evaluation Group Orlando, FL 32813		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS	11	12. REPORT DATE Apr[redacted]78 13. NUMBER OF PAGES 44 ~~12~~ 48p.
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified 15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution is unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Aircraft Only Training
Correlation of UPT Performance to Post UPT Performance
Flight Hour Substitution
Device 2F87F
Proficiency-Based Training
Training Effectiveness
Transfer of Training
P-3 Aircraft Training

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This study continues the investigation of the training effectiveness of Device 2F87F in fleet replacement training. The study examines:

- comparative data on first-tour pilots trained on principal P-3 flight tasks without correlative simulator training;
- training trials required to achieve proficiency in the flight simulator and in the aircraft; and → next page

DD FORM 1473 1 JAN 73 EDITION OF 1 NOV 65 IS OBSOLETE

S/N 0102-LF-014-6601

Unclassified

SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

407626

20. Abstract (continued)

performance in the flight simulator as a predictor of later performance in the P-3.

The analyses considered:

the number of in-flight hours required to complete the Familiarization/Instrument phase of Fleet Readiness Squadron (FRS) without previous training in Device 2F87F;

transfer effectiveness ratios for Device 2F87F;

benefits of landing practice in Device 2F87F; and

correlations between undergraduate pilot training (UPT) flight averages, UPT flight hours, and FRS performance.

ACKNOWLEDGMENT

The constant support and encouragement of Dr. Alfred F. Smode is gratefully acknowledged. His substantial technical guidance and many fruitful discussions on organizing the findings have contributed significantly to the report.

TABLE OF CONTENTS

TABLE OF CONTENTS (continued)

LIST OF ILLUSTRATIONS

LIST OF TABLES

SECTION I

INTRODUCTION

Much has been written on the developing engineering sophistication and the student centered instructional techniques in flight simulator design and utilization. Engineering advances combined with improved training strategies place the flight simulator in contention as a major flight training medium in today's military environment. There is an increasing awareness that simulators, efficiently utilized, can be employed to startling advantage in military flight training.

The Training Analysis and Evaluation Group (TAEG) is examining the extent that substitution of simulator training for in-flight training is feasible in the military training environment. The group has been working directly with Patrol Squadron THIRTY (VP-30) to maximize the use of existing training resources in fleet replacement pilot training of first-tour aviators in the P-3 aircraft.

A recent study[1] evaluated the effectiveness of the newly installed Device 2F87F Operational Flight Trainer (OFT) at the Fleet Readiness Squadron (FRS), VP-30. The study determined the training and cost effectiveness of the 2F87F as a replacement for the earlier generation 2F69D OFT when used in combination with the P-3 aircraft.

The study reported here is a continuation of the effort to integrate the 2F87F into the ongoing replacement pilot training program. Additional data are provided to aid in decisions for maximizing the role of the 2F87F simulator in the production of P-3 pilots.

PURPOSE

The present study continues the investigation of the training effectiveness of Device 2F87F by examining additional factors that influence device utilization. The specific objectives of the study are to determine the:

- performance of a group trained in the aircraft without previous simulator training to permit comparison with performance of matched groups having correlative simulator training,
- value of training trials for providing an index of student performance and device effectiveness,
- correlation of performance in Device 2F87F with performance in the P-3 aircraft,
- effect of undergraduate pilot training (UPT) performance on subsequent performance in FRS,
- performance of VP-30 trained students in subsequent operational assignments.

[1] R. F. Browning, L. E. Ryan, P. G. Scott, and A. F. Smode. Training Effectiveness Evaluation of Device 2F87F, P-3C Operational Flight Trainer. TAEG Report No. 42. 1977. Training Analysis and Evaluation Group, Orlando, FL. AD A035771.

A subsequent study will examine the influence of two additional major variables on the training effectiveness of Device 2F87F. These are the contribution of the visual system to performance in the final landing phase and the effect of removing simulation motion cues on the transfer of training.

PERSPECTIVE

As a prelude to the discussions which follow, several issues dealing with real world contexts should be noted. To begin with, the TAEG study program in the P-3 FRS community centered on assessing the contributions of a recently installed high fidelity flight simulator in transitioning pilots for assignment to P-3 squadrons. The goal of the program was to efficiently integrate Device 2F87F into the ongoing VP-30 pilot training program and to reduce P-3 aircraft in-flight training requirements.

The TAEG studies are of singular interest since all work was accomplished in the operational environment. Experimental control and standardized data collection were maintained in that a TAEG member was onsite at VP-30 during all formal studies. Guidance and support were provided to instructor pilots conducting the student performance evaluations. Training Analysis and Evaluation Group members observed student instruction both in the simulator and during aircraft training flights. The benefits of this "in situ" approach far outweigh the disadvantages of accommodating confounding influences and scheduling problems in the environment wherein VP-30 conducted business as usual. The most noteworthy among these involved data gathering constraints and range of instructor pilot experience levels. The latter included problems arising from instructor pilot rotation, use of instructors with primary duties other than flight instruction, and the biases associated with utilizing many instructor pilots in evaluation of student performance.

Another feature of importance was the opportunity to systematically assess the performance of a group of students trained <u>only in the aircraft</u>. This initiative is seldom exercised in studies conducted in the operational environment. Training such a group contributes powerfully to the study design in that baseline data are provided for assessing simulator contributions to the performance of groups trained in both the simulator and the aircraft. A measure is provided of the in-flight training required in the absence of a simulator.

Finally, operational implementation of a recommended training program was achieved. The syllabus of instruction used for the experiments with modifications imposed by simulator and aircraft availability was employed for three consecutive FRS classes. This phase of the study was accomplished by squadron personnel with TAEG in a consulting role. Although lacking in certain experimental controls and rigor, the data provide additional valuable insights for assessing simulator effectiveness in FRS training.

All told, the onsite measurement of simulator contributions to P-3 Familiarization/Instrument (FAM/INST) flight training afforded a unique opportunity for highly relevant evaluations within a tolerable range of experimental control.

ORGANIZATION OF THE REPORT

In addition to this introduction, four sections are presented. Section II presents comparative data on matched groups of first-tour pilots trained on principal P-3 tasks with and without correlative simulator training. The performance of a group of students trained in the aircraft without previous simulator training was measured to establish a baseline for comparison of performance for groups trained in Device 2F87F and the older OFT, Device 2F69D.

Section III describes the results of the operational implementation of the experimental simulator and flight syllabus for three entire classes with the concomitant problems of scheduling and sharing of the visual system rigid model. Summary data related to training trials required for each task are examined as a source of additional information on student performance and device effectiveness.

Section IV examines additional variables that presumably influence training outcomes in P-3 pilot training. The relationships between UPT flight scores, UPT flight hours, and FRS performance are analyzed. The feasibility of predicting performance in the aircraft based on performance in the flight simulator is explored. Finally the results of a followup questionnaire on pilots used in earlier experiments seeks to determine if any differences in performance between experimental and control students exists after assignment to an operational squadron.

Section V presents conclusions and recommendations developed during the study.

SECTION II

COMPARISON OF AIRCRAFT PERFORMANCE FOR SIMULATOR AND NON-SIMULATOR TRAINED STUDENTS

This section presents data on pilots trained on principal flight tasks in the P-3 aircraft without correlative training in the 2F87F flight simulator. The data on the performance of this group, hereafter referred to as the E-2 group, provide a baseline reference measure for determining the value or flight hour savings of alternative mixes of simulator and aircraft training. These baseline data are compared with the data from groups who received both simulator and aircraft training. The data were collected over a period of 8 months.

STUDY DESIGN

Three matched groups were identified in the design: a control group trained in the older OFT, Device 2F69D; an experimental group trained in the new OFT, Device 2F87F; and an experimental group trained in the P-3 aircraft without prior OFT training. Table 1 outlines the possible comparisons.

TABLE 1. STUDY DESIGN

CONTROL GROUP (C) N=58	EXPERIMENTAL GROUP (E-1) N=27	FLY ONLY GROUP (E-2) N=10
4 CFT	4 CFT	4 CFT
6 CPT	6 CPT	6 CPT
3 2F69D	6 2F87F	--
6 P-3 flights	4 P-3 flights	6 P-3 flights (minimum)

TRAINING TASKS. Twenty-two tasks selected by TAEG and the squadron were used as the basis for comparing performance of the three groups of pilots. This compares to 20 check tasks for the earlier group. The additional tasks were subsumed under other tasks in the earlier study. The tasks, identified by circles on figure 1, were considered most appropriate for measurement of pilot skills and simulation effectiveness of the new device.

TRAINING DEVICES UTILIZED IN THE STUDY. Descriptions of the two part-task trainers employed with all groups in the study; the older operational flight trainer, Device 2F69D, used to train the control group; and the newer operational flight trainer, Device 2F87F, used to train the first experimental group are provided below.

Cockpit Familiarization Trainer (CFT), Device 2C23. The CFT provides a static simulation of the pilot, copilot, and flight engineer positions. It is used to facilitate the learning of the nomenclature, location, and function of the various controls, instruments, switches, and annunciator lights. The device is well suited to the learning of repetitive tasks such as normal and emergency procedures.

Cockpit Procedures Trainer (CPT), Device 2C45. The CPT was developed from a modification of an obsolete P-3 OFT. The motion simulation, most of the flight dynamics, and unneeded systems were removed or disabled. The device in its present configuration provides training in power plant management and systems procedures for both normal and emergency operations.

Operational Flight Trainer, Device 2F69D. An older operational flight trainer configured to the earlier P-3A/B models was used in the training of the control group. This solid state analog device, which was the principal simulator used before delivery of the 2F87F, came into the inventory late in 1966 and provides crew or individual training for the pilot, copilot, and flight engineer. The 2F69D simulates the flight dynamics, systems, navigation, and communications functions of the P-3 aircraft and provides limited motion (3 degrees of freedom) and environmental cues. No visual simulation is provided. The device, with its analog simulation, requires considerable maintenance to insure high fidelity performance.

Operational Flight Trainer, Device 2F87F. This state of the art device simulates the flight stations (pilot, copilot, and flight engineer) of the P-3C Orion, a four-engine turboprop aircraft used to support landbased ASW and other long range surveillance and data gathering missions. The high fidelity digital device is equipped with a 6 degrees of freedom motion system and a visual capability which is a narrow angle (50^{o} horizontal, 38^{o} vertical) television rigid model system. A broad range of environmental conditions varying from full daylight color to darkness with variable visibility, ceiling, and wind conditions can be simulated. The model board simulates an area of approximately 15 X 5 nautical miles on a scale of 2000 to 1 for the low altitude maneuvers associated with takeoff, landing, and instrument approaches. Low altitude on-top conditions are simulated electronically, and high altitude simulation is provided by a high altitude model board.

SUBJECTS. Ten newly designated first-tour naval aviators from Class 76T03 were selected as subjects for the "Fly Only" (E-2) group. This group was matched on the basis of undergraduate basic and advanced flight scores with the control group (C) and experimental group (E-1). All subjects had completed undergraduate multiengine training in the S-2, a small twin reciprocating engine aircraft. All possessed standard instrument cards.

INSTRUCTORS. The most experienced VP-30 instructors were used to train the E-2 group. This was a safety precaution taken to offset student inexperience since none had any previous training in the 2F87F simulator. Each instructor was briefed by TAEG personnel on the purpose of the study, the proficiency-based grading system, and the data recording requirements. Flight checks for all students were given by off-wing instructors.

UNIVERSAL GRADE SHEET

TRAINEE: TRAINING SESSION

INSTRUCTOR FLIGHT TIME TOTAL

DATE FIRST PILOT TIME BRIEFING TIME

INSTRUMENT TIME: ACTUAL SIMULATED COPILOT TIME

FLIGHT WAS SATISFACTORY UNSATISFACTORY INCOMPLETE REMARKS ON BACK

	NO. TRIALS	P	AA	A	BA	U		NO. TRIALS	P	AA	A	BA	U
01 PREFLIGHT							25 FIRE UNK ORIG. (CPT)						
02 USE CKLST (CPT)							26 SMOKE REMOVAL (CPT)						
03 ENGINE STARTS							27 RES ELECT PWR (CPT)						
04 START MALF(CPT)							28 BAILOUT DRILL (CPT)						
05 TAXI							29 EMERG DESCENT (SIM)						
06 INSTR PROC							30 DITCH DRILL (SIM)						
07 ANTI ICE (CPT)							31 HOLDING						
08 BRAKE FIRE							32 NON PREC APP						
09 TAKEOFF							33 PREC APP						
10 ABORT 4 ENG							34 CIRCLING APP						
11 ABORT 3 ENG							35 MISSED APP						
12 EFAR							36 LDG PTRN AIRWORK						
13 DEPARTURE							37 NORMAL LANDINGS						
14 NTS							38 APPROACH FLAP LDGS						
15 BASIC ARWK							39 WAVEOFF						
16 LOITER SHTWN (CPT)							40 3 ENG LDG						
17 PROP MALF(CPT)							41 2 ENG LDG						
18 EMERG SHTWN (CPT)							42 NO FLAP LDG						
19 ENG RSTRT(CPT)							43 KNWLG PROCEDURES						
20 AIRCND/PRSR OP (CPT)							44 COPILOT RESP'S						
21 HYD SYS OP(CPT)							45						
22 FUEL SYS OP (CPT)							46						
23 MAV OMST FAO:													
24 ELEC SYS OP(CPT)													

Figure 1. Universal Grade Sheet

PROCEDURE

GROUND SCHOOL, CFT, AND CPT TRAINING. The Fly Only (E-2) group received the same ground school, CFT, and CPT training as the control (C) and the 2F87F trained (E-1) groups.

FLY ONLY GROUP IN-FLIGHT TRAINING. The Fly Only (E-2) group received in-flight training in the same tasks as the control (C) and the 2F87F trained (E-1) groups. The E-2 and C groups were scheduled for six P-3 flights and the E-1 group for four flights. However, some subjects in the E-2 group required up to eight flights to satisfactorily complete the flight check.

MEASUREMENT. During aircraft flights all students were assigned grades based on the conventional grading system used in Navy pilot training. In this system, referred to as the "U, BA, A, AA," (UBAA) the letter U denotes unsatisfactory performance and is equated to a numerical grade of zero; BA denotes below average and a grade of 2.5; A denotes average and a grade of 3.0; and AA denotes above average and a grade of 3.5. The numerical scores of all students were compiled and averages obtained for individuals and for the group.

For the purposes of the study a second measurement system based on attainment of proficiency in each task trained was used. Proficiency (P) was defined as performance estimated to be equivalent to that required to demonstrate competence on the conventional flight check. The proficiency measurement system was used in both the simulator and the aircraft. Instructors assigned a "P" to each task when it was performed to proficiency in the simulator and again when it was performed to proficiency in the aircraft. Proficiency was assumed for any task graded "A" or "AA" on the flight check.

RESULTS

The data are presented under two main topics: (1) Actual Flight Training Hours and (2) Proficiency-Based Flight Training Hours. The actual flight training hours are the average number of flight hours received by the C, E-1, and E-2 group students. The proficiency-based flight training data represent the number of flights required to attain proficiency on the designated check tasks.

ACTUAL FLIGHT TRAINING HOURS. Table 2 presents summary data on the three groups identified in the study. Undergraduate pilot training flight averages, average VP-30 flight hours, and VP-30 flight averages are shown.

The data of most interest concern the flight hour comparisons among the three groups. The first pilot[2] flight hours for the C and E-2 groups are identical (15.1 hours) which indicates that Device 2F69D, as utilized during this study, was not contributing to a reduction in flight hours. The 8.6 hours

[2] FAM/INST training at VP-30 is directed toward first pilot training (left seat) and only tasks performed in this position are graded.

TABLE 2. AVERAGE FLIGHT HOURS AND FLIGHT GRADES OF CONTROL AND EXPERIMENTAL GROUPS

	Device 2F69D & Flight Training	Device 2F87F & Flight Training	Flight Training Only
	C	E-1	E-2
Number of Students	58	27	10
Flight Average (UPT)	55.8	54.2	55.0
VP-30 Flight Hours Per Student	15.1	8.6	15.1
VP-30 Check Flight Average Grade	3.02	3.03	3.01

received by the E-1 group represent a 43 percent savings over both the C and E-2 groups. The flight hour savings are attributed to the effective utilization of Device 2F87F.

Savings in flight time is a good measure of the effectiveness of a training device. Another way of depicting simulator effectiveness is via the computation of the transfer effectiveness ratio (TER).[3]

The TER between the E-1 and E-2 groups is computed below and is provided as another way of displaying the findings of the study.

$$\text{TER} = \frac{\text{Flight Hours* (E-2) - Flight Hours* (E-1)}}{\text{Simulator Hours* (E-1)}}$$

$$\text{TER} = \frac{15.1 - 8.6}{12} = .54$$

*First Pilot Hours Only

The TER value indicates the hours of flight time saved for every hour of training in the simulator. The reader is cautioned not to interpret the .54 TER as a constant. The TER is not necessarily linear with increased training and it varies as a function of the tasks trained and the extent of previous practice.

[3] S. N. Roscoe. "Incremental Transfer Effectiveness." Human Factors. 13. 6. December 1971. pp. 561-567.

In addition to a comparison of flight hours required to train the three groups, table 2 presents the average check flight scores, the number of students in each group, and their average UPT flight grades. Although there are slight differences in the VP-30 check flight grades, these differences are not significant.

PROFICIENCY-BASED TRAINING HOURS. The following five tables provide data based on the proficiency (P) grading system. Table 3 presents the cumulative proportion of check tasks on which the E-1 and E-2 group trainees were judged proficient in the airplane.

TABLE 3. CUMULATIVE PROPORTION OF CHECK TASKS ON WHICH EXPERIMENTAL GROUPS WERE JUDGED PROFICIENT IN THE AIRCRAFT

	FLY 1	FL 2	FL 3	FL 4	FL 5	FL 6	FL 7	FL 8
Tasks trained to proficiency in Device 2F87F (E-1 Group)	.76	.87	.94	.99	.99*			
Tasks practiced in Device 2F87F but not trained to proficiency (E-1 Group)	.46	.60	.75	.96	1.00*			
Fly Only Group (E-2 Group)	.09	.34	.52	.57	.83	.91	.94**	.95**

* 1 student required 5 flights to achieve proficiency.
** 3 students required 7 flights and 1 student required 8 flights to achieve proficiency.

The experimental design for the E-1 group called for all 20 check tasks to be performed on FLY 1. For various reasons (e.g., maintenance problems, weather, instructor oversight), the actual number of tasks checked on FLY 1 varied from 9 to 19. Similarly, for the E-2 group, the number checked on FLY 1 ranged from 7 to 15 from a total of 22 check tasks. This lower range of tasks presented was expected for the E-2 group since this group had to achieve certain task skills without previous simulator exposure prior to attempting more complex tasks in the aircraft. The average number of tasks presented to the E-2 group on FLY 1 was 11.7. By FLY 4 the average number presented was 20.2. However, the trainees were judged proficient in only 57 percent of the tasks. The simulator trained group (E-1) did much better by FLY 4; trainees were judged proficient in 96 percent of the tasks if they had received some practice in the simulator and proficient in 99 percent of the tasks if training in the simulator was to proficiency. This offers additional evidence that the training of check tasks to proficiency in the 2F87F prior to in-flight training reduces the time for these tasks to be judged proficient in the aircraft. The data also show that in terms of proficiency attainment the E-2 group was not as well prepared for the flight check nor did they perform as well as the E-1 group on the flight check.

Table 4 presents a comparison of the attainment of proficiency on check tasks for the E-1 and E-2 groups. Data in this table are based on the assumption that a check task presented for the first time on FLY 1, 2, 3, or 4 and judged proficient on that flight, required only that one flight to be judged proficient and was scored as proficient on FLY 1.

TABLE 4. CHECK TASK PROFICIENCY ATTAINMENT

	EXPERIMENTAL GROUP E-1 N=27		EXPERIMENTAL GROUP E-2 N=10	
CHECK TASKS	AVERAGE FLIGHTS TO PROFICIENCY	SD	AVERAGE FLIGHTS TO PROFICIENCY	SD
Preflight	1.4	.84	2.5	.85
Use of Checklists	1.1	.27	1.9	.88
Engine Starts	1.0	.00	1.6	.84
Taxi	1.1	.42	2.6	.97
Instrument Procedures	1.6	.89	4.3	1.33
Brake Fire	1.1	.24	1.5	.53
Takeoff	1.1	.32	3.0	1.25
Abort Four Engines	1.1	.29	2.0	.94
Abort Three Engines	1.4	.75	1.8	.63
Engine Failure After Refusal	1.4	.69	2.3	.82
Departure	1.1	.20	2.8	1.03
Basic Airwork	1.6	1.01	3.7	1.77
Holding	*		1.6	.73
Non-precision Approach	1.3	.60	2.7	1.42
Precision Approach	1.4	.69	2.9	1.29
Landing Pattern Airwork	1.7	.92	3.3	1.70
Normal Landings	1.7	.94	4.6	1.78
Approach Flap Landings	#		2.0	1.05
Waveoff	1.2	.40	3.1	1.52
Three Engine Landings	1.7	.91	2.4	1.45
No Flap Landings	1.6	.74	1.8	.79
Knowledge of Procedures	1.4	.79	4.6	2.01

* Included in other phases of instruments.
\# Included under normal landings.

The column labeled, Average Flights to Proficiency, represents the number of flights the students flew in the P-3 before being judged proficient for that task.

For every task, proficiency in the aircraft was attained in fewer flights for the E-1 group than for the E-2 group. A task-by-task comparison indicates the benefits of Device 2F87F training to be the greatest for (1) Knowledge of Procedures, (2) Normal Landings, (3) Instrument Procedures, and (4) Basic Airwork. The beneficial effects of 2F87F training for Knowledge of Procedures

and Normal Landings were also reported in a previous study.[4] The findings of this study indicate that Device 2F87F is as effective for training the more difficult tasks as it is for training knowledge and procedural tasks. In 21 of the 22 tasks the standard deviation (SD) for the group trained only in the aircraft (E-2) was greater than for the group trained in the simulator and the aircraft (E-1). The data indicate that variability in task performance is less for simulator trained students than for those not trained in the simulator.

Table 5 shows the number of check tasks presented and the number of check tasks on which the E-2 group trainees were judged proficient. Table 6 presents the same information for the E-1 group. The table is reproduced from the previous study[5] and included here solely for comparison purposes.

Four students from group E-2 (7, 8, 9, and 10) required five flights to become proficient on all check tasks (average of 12.7 flight hours per student). Three students (3, 4, and 5) were proficient after six flights (13.8 hours). Two students (1 and 2) were proficient after seven flights (15.95 hours) and one student (6) required eight flights (17.7 hours) to become proficient in all check tasks. The average flight time for all students to attain proficiency was 14.2 hours. This compares to an average of 6.2 flight hours required by the E-1 group to become proficient. Based on the flight hours to proficiency, the TER is computed as follows:

$$\text{TER} = \frac{\text{Flight Hours to Proficiency (E-2)} - \text{Flight Hours to Proficiency (E-1)}}{\text{Simulator Hours (E-1)}}$$

$$\text{TER} = \frac{14.2 - 6.2}{12} = .67$$

The TER of .67 is greater than that obtained by comparing actual flight hours (.54 TER). It is viewed as a better estimate of the training effectiveness of the 2F87F since the use of proficiency hours represents a comparison of criterion referenced performance levels, whereas the use of actual hours represents a comparison of end-of-program performance levels.

The reliability of the proficiency-based grading system is attested to by the finding that in only 22 out of 1020 gradings were students subsequently given a grade below average on a task that had previously been judged proficient. This compares favorably with the findings from the previous TAEG study[6] where only 50 out of 1200 gradings were students subsequently graded below average on a task previously judged proficient.

[4] Browning, et al., op. cit.

[5] Ibid.

[6] Browning, et al., op. cit.

TABLE 5. NUMBER OF CHECK TASKS PRESENTED AND NUMBER OF CHECK TASKS ON WHICH TRAINEES IN THE E-2 GROUP WERE CERTIFIED PROFICIENT

TRAINEE	FLY 1		FLY 2		FLY 3		FLY 4		FLY 5		FLY 6		FLY 7		FLY 8	
	No. of Check Tasks Presented	No. Proficient	No. of Check Tasks Presented	No. Proficient	No. of Check Tasks Presented	No. Proficient	No. of Check Tasks Presented	No. Proficient	No. of Check Tasks Presented	No. Proficient	No. of Check Tasks Presented	No. Proficient	No. of Check Tasks Presented	No. Proficient	No. of Check Tasks Presented	No. Proficient
1	12	2	15	5	19	8	21	10	21	10	22	14	22	17*		
2	12	1	14	4	15	5	19	7	21	12	21	17	22	21*		
3	14	0	16	0	19	6	21	6	21	20	21	21*				
4	14	0	14	0	18	5	22	5	22	20	22	21*				
5	11	3	15	7	16	10	16	13	20	15	21	21*				
6	9	1	14	2	17	6	17	10	21	13	22	16	22	16	22	19*
7	7	1	16	16	18	18	21	21	22	22	22	22				
8	7	0	14	8	18	16	21	19	22	22	22	22				
9	14	1	14	6	17	8	22	12	22	22	22	22				
10	14	1	14	2	19	9	22	13	22	22	22	22				

*Proficiency assumed at this point even though all check tasks not judged "P"

TABLE 6. NUMBER OF CHECK TASKS PRESENTED AND NUMBER OF CHECK TASKS ON WHICH E-1 TRAINEES WERE CERTIFIED PROFICIENT[1]

	FLY 1		FLY 2		FLY 3		FLY 4		FLY 5	
TRAINEE	No. of Check Tasks Presented	No. Proficient	No. of Check Tasks Presented	No. Proficient	No. of Check Tasks Presented	No. Proficient	No. of Check Tasks Presented	No. Proficient	No. of Check Tasks Presented	No. Proficient
1	15	14	18	17	19	17	20	20	--	--
2	19	15	20	20	20	20	20	20	--	--
3	17	12	17	13	17	16	18	18	--	--
4	12	5	20	8	20	11	20	20	--	--
5	17	12	18	17	18	17	19	18	--	--
6	17	14	18	14	18	18	19	19	--	--
7	18	14	19	19	20	20	20	20	--	--
8	17	8	19	10	20	15	20	20	--	--
9	13	8	16	8	19	8	20	17	20	20
10	12	12	18	18	19	19	19	19	--	--
11	12	3	19	12	19	19	19	19	--	--
12	13	5	19	11	19	18	19	19	--	--
13	18	18	20	20	20	20	20	20	--	--
14	16	9	18	12	18	16	19	19	--	--
15	15	14	16	16	18	18	18	18	--	--
16	14	11	18	16	18	18	18	18	--	--
17	16	16	20	20	20	20	20	20	--	--
18	17	11	20	18	20	18	20	19	20	20
19	14	11	19	18	19	19	20	20	--	--
20	15	15	20	20	20	20	20	20	--	--
21	16	16	17	17	19	19	20	20	--	--
22	12	10	20	20	20	20	20	20	--	--
23	12	12	18	18	18	18	18	18	--	--
24	14	4	19	16	19	16	20	20	--	--
25	15	6	19	17	20	19	20	19	--	--
26	11	6	14	14	16	16	18	18	--	--
27	9	6	13	7	15	12	19	19	--	--

NOTE: Each "FLY" represents 2.11 flight hours. Only two students required five flights.

[1]Taken from TAEG Report No. 42

LANDING PERFORMANCE

Great concern is devoted to the landing task in P-3 flight training, and more time is spent in training this skill than any other task in the syllabus. Concomitant with the concern is the belief by squadron instructors and pilots that landing practice in Device 2F87F does not transfer to the aircraft because the device does not realistically simulate the aircraft performance during the final landing phase. The most prominent complaint is the lack of peripheral cues (purportedly required for landing) attributed to the narrow field of view of the visual system. The design of this study provided an opportunity to test this contention.[7] A comparison was made of the number of landings required to achieve proficiency and the number of landings actually received by both the simulator and the aircraft trained groups. Table 7 presents the average number of landings required by both groups to attain proficiency and the number actually received.

TABLE 7. AVERAGE NUMBER OF LANDINGS

	Device 2F87F Landings	Aircraft Landings	
		Actual	To Proficiency
E-1	28*	36	17
E-2	--	60	50

*Estimated from computer printouts

The E-2 group required 24 more landings per student to complete the FAM/INST phase of fleet readiness training and 33 more landings per student to attain proficiency in landings. It is interesting to note that the simulator trained group (E-1) required a combination of 45 landings (28 simulator and 17 aircraft) to achieve proficiency whereas the Fly Only group (E-2) required 50 aircraft landings to achieve proficiency.

SUMMARY OF FINDINGS

The findings discussed in this section are summarized below:

1. The older (Analog) Device 2F69D as utilized during the period of this study and immediately prior to acceptance of Device 2F87F did not provide significant transfer of training to the aircraft for dynamic flight tasks.

[7] A subsequent TAEG study will address transfer of training in the final phase of landing. Students will be trained in the landing pattern task in the simulator. However, the task will be terminated at the "Select Land Flaps" position by either "freezing" the trainer or initiating a waveoff.

2. Students trained in the aircraft without prior OFT training (the E-2 group) required an average of 6.5 more flight hours in the P-3 aircraft to complete the FAM/INST phase of training than did the E-1 group. With the additional flight hours their flight grades were lower than the grades of pilots trained in Device 2F87F and the P-3 aircraft.

3. Based on actual flight training hours received the TER for Device 2F87F is .54 (for every hour in the simulator, .54 hours of flight time are saved). When a proficiency grading system is used the TER is increased to .67. This suggests that if training on each task is terminated upon reaching proficiency, 1 hour of simulator time would substitute for .67 hours of flight time.

4. The Fly Only group received 24 more aircraft landings than the group receiving simulator and aircraft training. They required 33 more landings to achieve proficiency (table 7). It should be noted that the simulator group required fewer total simulator and aircraft landings to attain proficiency than did the aircraft only trained group. This suggests, that the task learned in the simulator transfers significantly to subsequent aircraft landing performances.

SECTION III

TRAINING TRIALS AS AN INDEX OF STUDENT PERFORMANCE AND DEVICE EFFECTIVENESS

During the conduct of the P-3 study program, it became increasingly clear that training trials data (i.e., data on individual training trials) would provide important information about student performance and could provide valuable inputs towards determining the training effectiveness of Device 2F87F.

The opportunity to gather training trials data on tasks for both first- and second-tour students emerged with the acceptance of a second Device 2F87F at VP-30. The data were collected by VP-30 instructor pilots after a brief indoctrination by TAEG personnel. The Training Analysis and Evaluation Group did not monitor the collection effort but did conduct all data analyses.

This phase of the study lacked in certain experimental controls since the data were gathered solely by squadron personnel during day-to-day operations. However, the data are of sufficient substance and value to provide insights concerning training strategies, grading criteria, program control, and the value of Device 2F87F for training individual tasks.

DATA COLLECTION

Data for this phase of the study were collected from three consecutive classes of students (classes 7703, 7704, and 7705), hereafter referred to as the "O" group. The grade sheets modified to collect task trials (figure 2) were completed on each student and forwarded to TAEG for analysis.

MEASUREMENT. In addition to the "UBAA" grading system, the previously defined proficiency grading system was used. Proficiency (P) was defined as performance estimated to be equivalent to that required to demonstrate competence on the conventional flight check.

For tasks 2, 3, 4, 6, 13, 15, 35, 36, and 43 (see figure 2), P was assigned by the instructor in accordance with the proficiency definition stated above. For tasks 8, 9, 10, 11, 12, 31, 32, 32A, 32B, 32C, 33, 33A, 37, 38, 39, 40, and 42, trial performance was recorded by the instructor as either a 1 or a P, and TAEG determined the point at which P was attained for each task. The procedure for making this determination was as follows: the trial performance was recorded by the instructor as "1" (meaning one trial) or "P" (meaning one trial that was proficient). For example, 10 normal landings on any flight might have been graded 11P11PP111; of the 10 trials, 7 were not proficient and 3 were proficient. The rule used by TAEG for determining the point when P was attained is as follows: (1) over 50 percent of the trials (for a given task) on any flight had to be P <u>and</u> (2) at least 50 percent of the trials were P on all subsequent flights. An exception to (1) and (2) could occur on the check flight. If on the aircraft check flight a UBAA grade of A or AA was assigned by the instructor, then P was assigned by TAEG no matter how the individual trials were graded. Attainment of proficiency

RECORD TYPE 2

SS NO.(CC2) PILOT UNIVERSAL GRADE SHEET

TRAINEE (CC11) CLASS/CREW (CC31) TNG SESS (CC36)

INSTR(CC46) FLT TIME TOT(CC66) 1st PLT(CC70) CO PLT(CC74)

DATE(CC78) MO DAY YR INSTRUMT TOT (CC84) ACT(CC88) SIM(CC92)

TIME SESSION STARTED(CC96) SESSION ENDED (CC100)

FLIGHT WAS: SATISFACTORY(CC104) UNSAT(CC105) INCOMPLETE(CC106)

RECORD TYPE 3

(CC11)	(CC14) GRADED ITEMS	(CC15) NOT DONE	(CC46) NO. TRIALS/P	(CC66) AA	(CC67) A	(CC68) BA	(CC69) U
01. BRIEFING							
02. PREFLIGHT							
03. USE CHECKLIST							
04. ENGINE STARTS							
05. START MALF							
06. TAXI							
07. ANTI ICE							
08. BRAKE FIRE							
09. TAKEOFF							
10. ABORT 4-ENG							
11. ABORT 3-ENG							
12. EFAR							
13. DEPARTURE							
14. NTS							
15. BASIC ARWK							
16. LOITER SHTWN							
17. PROP/ENG MALF							
18. EMERG SHTWN							
19. ENG RSTRT							
20. AIRCND/PRSR							
21. HYD SYS OP							
22. FUEL SYS OP							
23. NAV INST FAIL							
24. ELECT SYS OP							
25. FIRE UNK ORIG							
26. SMOKE REMOVAL							
27. RES ELECT PWR							
28. BAILOUT DRILL							
29. EMERG DESCENT							
30. DITCHING DRILL							
31. HOLDING							
32. NON PREC APP TACAN							
32A VOR							
32B NDB							
32C LOC							
33. PREC APP GCA							
33A ILS							
34. MISSED APP							
35. INST PROCEDURES							
36. LANDING PTRN AIRWK							
37. NORMAL LANDINGS							
38. APPROACH FLAP LDGS							
39. WAVEOFF							
40. 3-ENG LANDINGS							
41. 2-ENG LANDINGS							
42. NO FLAP LDG							
43. KNWLG PROCEDURES							
44. COPILOT RESP							
45. HEADWORK							
46.							
47.							

Figure 2. Universal Grade Sheet (Revised)

for a task was determined by TAEG to reduce the inconsistencies occurring when P is determined by a number of instructors and to standardize this difficult measurement.

SEQUENCE OF TRAINING. Instructors were briefed to train all tasks to proficiency in the simulator before proceeding to the aircraft whenever possible. This goal was not uniformly reached, due, in part, to a revised sequence of training (see table 8) which was dictated by aircraft availability.

TABLE 8. SEQUENCE OF SIMULATOR AND FLIGHT TRAINING FOR THE O GROUP (CLASSES 7703, 7704, AND 7705)

SIM 1	SIM 5
SIM 2	FLY 2**
SIM 3	SIM 6
SIM 4	FLY 3***
FLY 1*	FLY 4

NOTE: Due to aircraft availability:
*FLY 1 followed SIM 5 for some students,
**FLY 2 followed SIM 6 for some students, and
***FLY 3 preceded SIM 6 for some students.

The acceptance of the second flight simulator required that two cabs share the visual system low altitude model board. Although sharing of the model board did not reduce training time for tasks requiring visual simulation by 50 percent (as one cab can use the electronically generated horizon scene for high altitude work), it may have had some effect on training. Additionally, conflicts in sharing the model board resulted in some students not receiving equal time on the board. The effect of this variable was not isolated during the study.

ANALYSIS AND RESULTS

The data are presented under three topics: (1) Actual Flight Training Hours Received, (2) Proficiency-Based Training, and (3) Simulator and Aircraft Task Trial Data.

FLIGHT TRAINING HOURS

Table 9 provides a summary of the performance of the O Group and compares this performance to that of the earlier experimental group (E-1).

TABLE 9. COMPARISON OF PERFORMANCE FOR 0 AND E-1 GROUPS

	0 Groups			Combined 0 Group	E-1 Group
	7703	7704	7705		
Number of Students	14	17	8	39	27
UPT Flight Average	56.9	49.9	49.3	52.3	54.2
VP-30 Flight Hours per Student	9.8	9.7	9.2	9.6	8.6
VP-30 Average Check Flight Grade	3.02	3.00	2.96	3.00	3.03

The average flight hours for the 0 group to complete the FAM/INST phase are 9.6, an increase of 1 hour over the E-1 group. This difference could be reasonably due to a number of factors, specifically:

- change in student input quality (increased variance in UPT scores),
- degradation of Device 2F87F simulation quality,[8]
- more difficult criterion for attainment of proficiency,
- instructor inexperience,
- change in training sequence; i.e., integrated vs. block training, and
- failure to train to proficiency in Device 2F87F.

Unfortunately, the specific impact of each of these variables is not known. However, subsequent discussion will consider these variables, as appropriate.

As shown in table 9, the UPT flight average of the 0 group is not significantly different from the E-1 group, but the UPT flight averages for two of the classes included in the 0 group are significantly lower. The relationship of undergraduate flight scores to undergraduate flight hours and to later performance at VP-30 is discussed in section IV of this report. The VP-30 flight check average for the 0 group, 3.00, is not significantly different from that of the control and previous experimental groups ($t_{df64} = 1.27$).

[8] Simulators were beset by a number of maintenance problems during the period of 0 group training. VP-30 has since established a policy of not accepting the simulator for training if essential simulation is unusable.

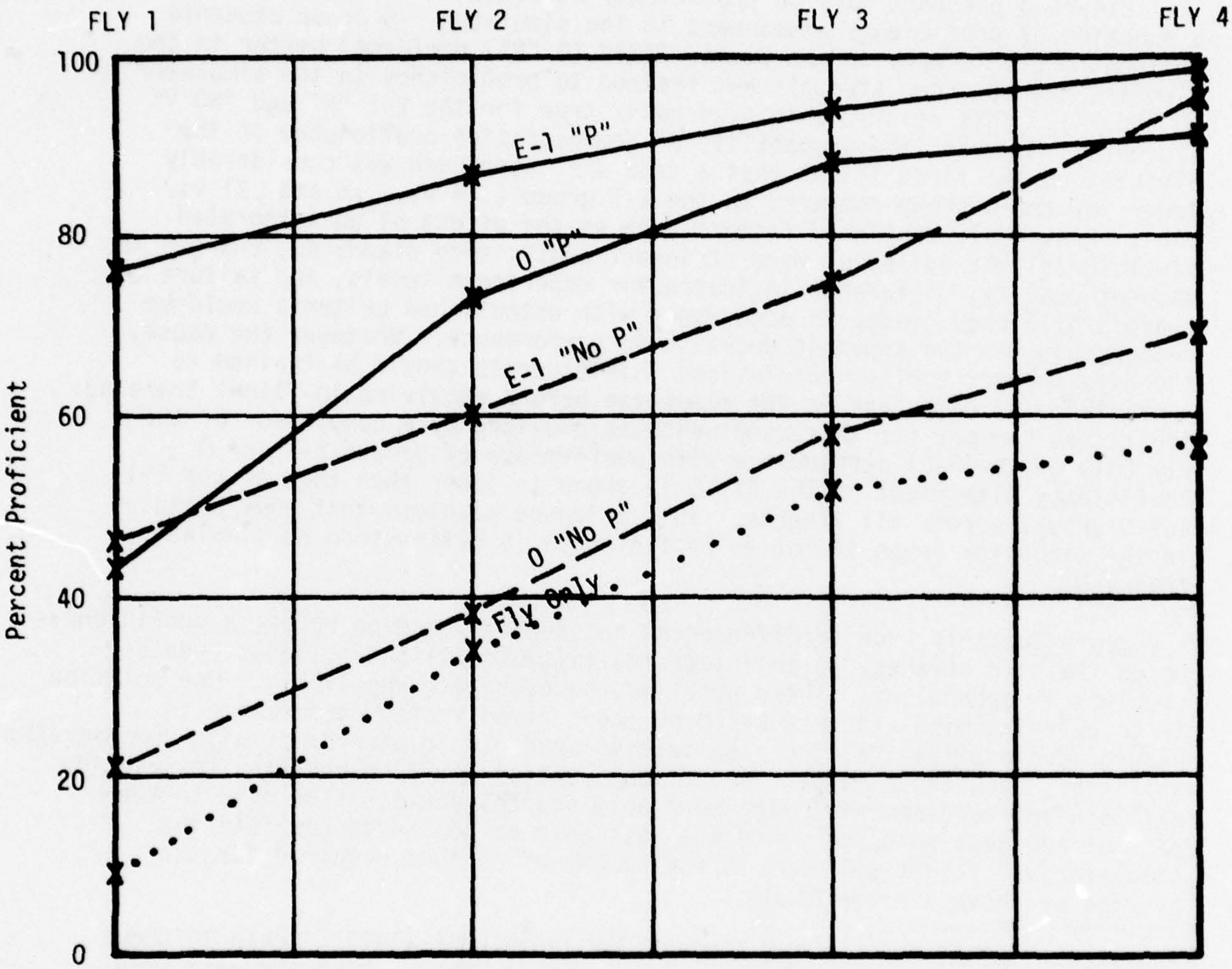
PROFICIENCY-BASED TRAINING

Figure 3 presents data on proficiency attainment in the P-3 aircraft as a function of proficiency attainment in the simulator. O group students trained to proficiency in the Device 2F87F (O "P") performed better in the aircraft than O group students not trained to proficiency in the simulator (O "NO P"). This relationship also holds true for the E-1 "P" and "NO P" students. However, the probability of demonstrating proficiency in the aircraft on the first flight that a task was introduced was considerably lower for the O group compared to the E-1 group (.44 vs. .76 and .21 vs. .46). Previously mentioned factors such as the effect of an integrated simulator/flight syllabus, more stringent proficiency standards, changes in student quality, difference in instructor experience levels, and failure to award proficiency grades in accordance with established criteria could be responsible for the apparent decrease in performance. Whatever the cause, the data support earlier conclusions that students should be trained to proficiency in each task in the simulator before receiving in-flight training. Additional support for this conclusion is provided by a comparison of the Fly Only group (E-2) performance with performance of groups E-1 and O. Proficiency attainment of the Fly Only group is lower than that of the E-1 and O groups across all flights. This evidence suggests that some training in the simulator (even if not to proficiency) is better than no simulator training.

Unfortunately, due to differences in student learning rates, a proficiency-based training strategy in an integrated simulator/flight syllabus creates problems in scheduling. These problems, however, are resolvable. One solution is to pair incoming students based on their demonstrated performance in undergraduate pilot training. By pairing students in accordance with demonstrated abilities, both the simulator and flight syllabi could be modified to coincide with student requirements. The more able student would not be held to the pace of the less able nor would the less able be pushed to complete the simulator and flight syllabus in the number of periods required for the average or above average student.

PROFICIENCY ATTAINMENT IN THE AIRCRAFT ON INDIVIDUAL TASKS. Table 10 shows the cumulative proportion of individual check tasks on which students were judged proficient in the aircraft differentiated by whether or not proficiency had first been attained in the flight simulator. As expected, the benefits of training to proficiency in the simulator are most noticeable on Fly 1 and Fly 2. The differences in proficiency attainment are diminished as both groups approach asymptotic performance.

Table 10 highlights apparent deficiencies in the training received by the O group. As shown, the performance (probability of proficiency) on Fly 1 was below .50 for 13 of the check tasks that had been trained to proficiency in the simulator. Considering the CFT, CPT, and OFT training that preceded Fly 1, proficiency attainment could reasonably be expected to be higher than .50. For example, such tasks as preflight, use of checklists, and engine starts should have been trained to proficiency before leaving the CPT. These skills should have been refreshed, reinforced, and checked for proficient



Note: Data in this figure are based on the assumption that a check task presented for the first time on Fly 1, 2, 3, or 4 and judged proficient on that flight required only one flight to be judged proficient.

"P" = Trained to proficiency in 2F87F.
"No P" = Not trained to proficiency in 2F87F.

Figure 3. Cumulative Attainment of Proficiency in the Aircraft as a Function of Proficiency Attainment in the Simulator

TABLE 10. CUMULATIVE PROPORTION OF INDIVIDUAL CHECK TASKS ON WHICH STUDENTS FROM THE COMBINED O GROUP WERE JUDGED PROFICIENT IN THE AIRCRAFT

		CUMULATIVE PROPORTION OF CHECK TASKS JUDGED PROFICIENT							
		FLY 1		FLY 2		FLY 3		FLY 4	
Task No.	Task	P in SIM	Not P in SIM	P in SIM	Not P in SIM	P in SIM	Not P in SIM	P in SIM	Not P in SIM
2.	Preflight	.43	.11	.77	.29	.85	.75	-	1.00
3.	Use of Checklists	.58	.36	.84	.58	1.00	.82	-	1.00
4.	Engine Starts	.57	.50	.86	.70	.93	.95	1.00	.95
6.	Taxi	.33	.14	.75	.27	.75	.67	.75	1.00
8.	Brake Fire	1.00	.55	-	1.00	-	-	-	-
9.	Takeoff	.24	.25	.73	.53	.86	.86	1.00	1.00
10.	Abort Four Engines	.53	.17	.91	.55	-	.86	-	-
11.	Abort Three Engines	.50	.21	.88	.48	-	.89	-	-
12.	Engine Failure After Refusal	.31	.07	.62	.54	.92	.91	-	-
13.	Departure	.41	.37	.64	.53	.81	.86	.95	1.00
15.	Basic Airwork	.43	.18	.50	.32	.63	.59	1.00	.96
31.	Holding	.54	.38	.83	.62	1.00	.86	-	-
32.	a. TACAN/VOR	.41	0	.87	.14	.93	.65	-	.88
	b. NDB	-	.18	-	.50	-	-	-	-
	c. LOC	1.00	.28	-	.64	-	.78	-	.88
33.	a. GCA	.28	.08	.59	.17	.94	.75	-	.87
	b. ILS	1.00	.63	-	-	-	-	-	-
35.	Instrument Procedures	.67	.11	.75	.29	.92	.68	1.00	.97
36.	Landing Pattern Airwork	.25	.11	.75	.52	.75	.77	1.00	.97
37.	Normal Landings	.31	.07	.38	.12	.92	.42	1.00	.79
38.	Approach Flap Landings	.81	.28	.90	.56	1.00	.75	-	.91
39.	Waveoff	.56	.43	.75	.59	1.00	.80	-	.88
40.	Three Engine Landings	.20	.14	.60	.36	.90	.91	-	1.00
42.	No Flap Landings	.27	.22	.91	.76	-	1.00	-	-
43.	Knowledge of Procedures	.29	.16	.60	.31	.86	.54	1.00	.85

- = Not presented.

performance in the OFT. Instrument skills such as holding, instrument procedures, precision and non-precision approaches plus knowledge of procedures, particularly those that had been trained to proficiency in Device 2F87F, should only require validation in the aircraft. Based on performance on Fly 1, much of the CPT and OFT training was not effective, did not transfer, or was forgotten prior to aircraft training. Past research has adequately demonstrated the effectiveness of synthetic devices for training these tasks. It is therefore concluded that the training provided for this group was not as effective as it might have been.

The tasks listed in table 10 that benefit most on Fly 1 and Fly 2 from proficiency training in the simulator are (1) Instrument Procedures, (2) Aborts, (3) Precision and Non-precision Approaches, and (4) Landings. For the Normal Landing Task, all students trained to proficiency in the simulator reached proficiency in the aircraft by Fly 4. Although other tasks were also judged proficient for all students by Fly 4, the difference between the proficiency attainment for the "P in the simulator" students and the "Not P in the simulator" students was most pronounced for the normal landing task.

SIMULATOR AND AIRCRAFT TASK TRIAL DATA

The number of trials received and the number of trials to proficiency in the simulator and the aircraft were obtained for all O group students. Data on trials were collected for the tasks shown in table 11. Table 11 shows trial data per task in terms of the number of students achieving P in each task, the average number of trials to proficiency, the number of students not trained to P for each task, and the average number of trials that they received. No task was trained to proficiency for all students, nor was any student trained to proficiency in all tasks. The total possible cases in which students could be trained to proficiency was 624 (39 students x 16 tasks). The actual cases in which students were trained to proficiency was 214, or 34 percent of the cases. This is contrasted to an attainment of proficiency in 90 percent of the cases for the first experimental group, E-1.

The average number of trials to proficiency for a given task was generally fewer than the average number of trials received on the same task by students who did not achieve proficiency. The failure of students to attain proficiency on a given task can be attributed to student ability, ineffective instruction, or failure of the instructor to assign a P if proficiency was attained. Unfortunately for the O group, the inexperienced instructors consistently awarded fewer Ps than did the experienced instructors.

AIRCRAFT TRIALS BY TASK AS A FUNCTION OF PROFICIENCY ATTAINMENT IN THE 2F87F. The relationship between overall simulator performance and later performance in the aircraft was discussed in section II. Table 12 presents the same relationship on a per task basis. On most tasks if proficiency was first attained in the simulator, the number of trials required to achieve proficiency in the aircraft were fewer than if these tasks were not trained to proficiency in the simulator. The difference in the number of trials is not significant, but the probability of a P in the aircraft if given a P in the simulator is high. These probabilities are shown in table 12. The group trained to P in

TABLE 11. SIMULATOR TRIALS RECEIVED AND SIMULATOR TRIALS TO PROFICIENCY

Tasks	No. of Students Attaining Proficiency	Average Trials to Proficiency	No. of Students NOT Attaining Proficiency	Average Trials Received
Brake Fire	3	1	36	.8
Abort Four Engines	21	1.5	18	2.1
Abort Three Engines	14	2.9	25	7.5
Engine Failure After Refusal	17	2.4	22	5.1
Departure	29	2.3	10	3.5
Holding	14	4.1	25	3.1
TACAN/VOR	18	3.5	21	7.8
NDB	0	-	39	.15
LOC	4	1.8	35	.8
GCA	22	2.2	17	3.4
ILS	7	1.7	32	1.2
Normal Landings (Land Flap)	13	10.2	26	13.5
Approach Flap Landings	12	4.0	27	7.1
Waveoff	11	1.8	28	4.5
Three Engine Landings	11	4.1	28	4.0
No Flap Landings	18	1.4	21	2.9

the simulator equaled or bettered the group not trained to P in the simulator in all but task 31. Although not shown, the following probabilities were derived from table 12. If proficiency is first attained in the simulator, the probability of attaining proficiency in the aircraft is .84. Whereas if proficiency is not attained in the simulator, the probability of attaining proficiency in the aircraft is .60. One is cautioned, however, not to conclude that the probability of a P in the aircraft associated with a P in the simulator is due solely to simulator training. The possibility exists that a P in the aircraft is related to the ability of the student. Determining the exact relationship is difficult. This is discussed in section IV of this report.

THE LANDING TASK TRIAL DATA. Concurrent with the introduction and acceptance of visual simulation into the training mission of simulators, speculation exists about the efficacy of visual systems for training the landing tasks. Despite the evidence that simulator trained students required fewer landings in the aircraft than students not trained in the simulator,[9] many instructors expressed doubt concerning the effectiveness of Device 2F87F for training the landing task. However, based on evidence to date Device 2F87F with its visual system is more effective for teaching Normal Landings than any other task. Table 13 compares the average number of landing trials received and the average number of trials to proficiency for the E-2, E-1, and 0 groups.

[9] Browning et al., op. cit.

TABLE 12. AIRCRAFT TRIALS AS A FUNCTION OF PROFICIENCY ATTAINMENT IN DEVICE 2F87F

Task No.	Task	PROFICIENCY ATTAINED IN SIMULATOR					PROFICIENCY NOT ATTAINED IN SIMULATOR				
		Proficient in Aircraft			Not Proficient in Aircraft		Proficient in Aircraft			Not Proficient in Aircraft	
		Number of Students	Average Trials to Proficiency	Probability of Proficiency	Number of Students	Average Trials Received	Number of Students	Average Trials to Proficiency	Probability of Proficiency	Number of Students	Average Trials Received
8.	Brake Fire	2	1.0	.67	1	0	17	1.0	.47	19	5
10.	Abort Four Engines	13	1.4	.62	8	1.5	7	1.4	.39	11	1.9
11.	Abort Three Engines	12	1.2	.86	2	4.5	21	2.5	.84	4	5
12.	Engine Failure After Refusal	15	2.2	.88	2	6.0	19	2.7	.86	3	5.7
13.	Departure	26	1.9	.90	3	2.3	9	1.6	.90	1	3
31.	Holding	12	1.1	.86	2	1.5	23	1.5	.92	2	2
32a.	TACAN/VOR	16	1.3	.89	2	2.0	15	2.5	.71	6	2.7
b.	NDB	0	-	-	0	-	4	1.3	.10	35	.4
c.	LOC	2	1.0	.50	2	1.0	10	1.3	.29	25	.8
33a.	GCA	17	2.8	.77	5	2.6	12	2.9	.71	5	5.8
b.	ILS	3	2.3	.43	4	.5	4	2.0	.12	28	.2
37.	Normal Landings	13	17.6	1.00	0	-	22	19.1	.85	4	31.8
38.	Approach Flap Landings	12	2.3	1.00	0	-	24	3.4	.89	3	8.3
39.	Waveoff	10	2.1	.91	1	2.0	20	2.0	.71	8	2.8
40.	Three Engine Landings	11	3.2	1.00	0	-	24	3.7	.86	4	4.5
41.	No Flap Landings	16	1.8	.89	2	1.5	15	1.8	.71	6	2.2

TABLE 13. AIRCRAFT LANDING TRIALS RECEIVED AND TRIALS TO PROFICIENCY

	Average Trials Received	Average Trials To Proficiency
E-2 Group (N = 10)	60	50
E-1 Group (N = 27)	36	17
O Group (N = 39)	45	28

Both the E-1 and O groups received fewer trials than the E-2 group. They also required fewer trials to attain proficiency than the E-2 group. Based on interviews with instructor pilots, the differences between E-1 and O group landing trials are most likely related to a more rigid grading criterion imposed by instructors of the O group.

Although there are differences between the E-1 and O group in the number of landings required to achieve proficiency, the evidence indicates that landing practice in the 2F87F provides positive transfer of training to the P-3 aircraft regardless of variations in student abilities, differences in grading criteria, or instructor experience.

SUMMARY OF FINDINGS

The findings discussed in this section are summarized below.

1. The O group students required an average of one flight hour more than the E-1 group to complete the FAM/INST phase of FRS training.

2. Tasks trained to proficiency in Device 2F87F for the O group have a higher probability of being judged proficient earlier on aircraft flights than tasks not trained to proficiency in the simulator. This finding is similar to the results obtained earlier.[10]

3. O group students were trained to proficiency in the simulator in only 34 percent of the cases as compared to 90 percent for the first experimental group (E-1).

4. The probability of attainment of proficiency on most tasks on Fly 1 was lower than expected since these tasks had been previously trained in the CFT, CPT, and OFT and proficiency demonstrated in either the CPT or OFT (see table 12).

[10] Browning, et al., op. cit.

5. The probability of attaining proficiency in a task by Fly 4 is .84 if the student had been trained to "P" in that task in the 2F87F. This is compared to a probability of .50 if the student had not been trained to "P" in that task in the 2F87F.

6. The performance of the O group again demonstrated that Device 2F87F provides positive transfer of training to the P-3 aircraft for every task in the FAM/INST phase of FRS training.

7. The 2F87F is more effective for training landings than for any other task in the syllabus.

SECTION IV

ADDITIONAL CORRELATES OF PERFORMANCE RELEVANT TO FRS PILOT PRODUCTION

Previous sections of this report examined the effectiveness of Device 2F87F for maneuver/task training and demonstrated the simulator's capability as a direct substitute for aircraft training. In this latter determination, training effectiveness ratios were computed to provide quantitative indicants of tradeoff possibilities.

During this study, variables beyond those formally considered in the evaluation were identified that could influence training decisions in the production of P-3 pilots. This section describes these variables and their effects on performance in the FRS and in subsequent assignments.

Three classes of relationships are examined for student groupings:

- performance (flight grades and flight hours) in UPT and subsequent performance in FRS,
- performance in the 2F87F OFT and its effect on subsequent performance in the air,
- FRS performance as a predictor of performance in operational assignments.

Each of the relationships contribute to the effectiveness of the VP-30 FAM/INST phase of training.

PERFORMANCE IN UPT AND SUBSEQUENT PERFORMANCE IN FRS

A VP-30 message to the Commander, Patrol Wings Atlantic,[11] provided the impetus to investigate the relationships between UPT flight hours and UPT fight averages to FRS performance. An excerpt from the message is provided below.

> "2. WITH THE DELETION OF DEDICATED SYLLABUS INSTRUMENT TRAINING FLIGHTS AND MAR 76 INTRODUCTION OF THE 2F87 OFT, FRS STUDENT HOURS HAVE BEEN REDUCED OVER 50 PER CENT SINCE 1973. THE ORIGINAL PLANNING FOR THESE REDUCTIONS WAS BASED ON THE ESTIMATED CAPABILITIES OF THE 2F87 AND AN UNDERGRADUATE PILOT TRAINING (UPT) STUDENT INPUT OF 260 HOURS. WHEN THE ACTUAL FRS REDUCTIONS WERE MADE, CHANGES IN UPT HAD REDUCED INPUT HOURS TO THE CURRENT AVERAGE OF 205. ALTHOUGH IT APPEARS THAT THE CURRENT SYLLABUS IS MAINTAINING FLEET STANDARD, THE OPTIMUM SIMULATOR FLIGHT MIX MAY REQUIRE ASSESSMENT."

The concern of the FRS is understandable if UPT students with fewer flight hours perform poorly compared to students logging a greater number of flight hours. However, analysis of the data involving 59 students indicated

[11] PATRON THREE ZERO Message 072200Z Jun 77

that concern over reduced flight time upon graduation from UPT is not justified. Comparisons and correlation of UPT flight hours, UPT flight averages, and VP-30 flight averages are presented in table 14. The overall VP-30 flight average rather than the Fly 4 check grade has been used as it provides a more stable measure of performance than a one-time measure such as the Fly 4 check flight.

TABLE 14. COMPARISONS AND CORRELATION OF UPT PERFORMANCE, UPT FLIGHT HOURS, AND VP-30 PERFORMANCE

UPT Flight Average	Average UPT Flight Hours	VP-30 Average Flight Grade
> 59	197	3.05
50-59	203	3.04 (t=.78, not sig. at .05 level)
< 50	218	2.92 (t=4.03, sig. at .01 level)

	r_{xy}	Significance Level
UPT Flight Average vs. UPT Flight Hours	-.59	.05
UPT Flight Average vs. VP-30 Flight Average	.50	.01
UPT Flight Hours vs. VP-30 Flight Average	-.29	.05

The data show an inverse relationship between UPT flight grades and UPT flight hours--the greater the number of UPT flight hours the lower the flight grade in UPT. The same relationship exists for UPT flight hours and FRS performance at VP-30. The correlation between UPT flight average and FRS flight average is significant at the .01 level.

A review of VP-30 flight averages beginning in 1972 and continuing at intervals to the present, indicates that the average grade has been about 3.03 with no drop coincident with the decrease in programmed UPT flight hours.

During the TAEG evaluations it was noted that some classes required more flight hours than other classes even though UPT class averages were the same. The probable explanation is that in a "lock step" curriculum all students are scheduled to receive at least four flights without regard to performance. Those students who have problems may get reflys for various flights; those who do not pass the Fly 4 check are given additional checks until they pass or are set back to a later class. Generally, these are students with UPT flight scores of less than 50. The students with high UPT flight scores that perform well at VP-30 still receive a minimum of four flights. Thus, for a class with a large variance in UPT flight scores, the UPT class average may remain near the historical mean, but the FRS flight hours will vary upward due to performance of below average students.

CORRELATION BETWEEN SIMULATOR AND FLIGHT PERFORMANCE

The importance of attaining proficiency in the flight simulator on each task prior to training in the aircraft suggested the need to examine correlations between performance in the simulator and later performance in the aircraft. The results of these analyses are presented in table 15.

TABLE 15. CORRELATION OF SIMULATOR PERFORMANCE AND FLIGHT PERFORMANCE

	r_{xy}	Significance Level
VP-30 Simulator Average vs. Flight Average	.46	.05
Performance in the Simulator on Instrument Tasks vs. Performance in the P-3*	.65	.05

* Instrument tasks include holding, precision and non-precision approaches and instrument procedures.

The data indicate that the correlation between simulator performance and later performance in the aircraft is significantly correlated as is the performance on specific instrument tasks to later performance in the aircraft. These findings, while not cross validated, support a conclusion that student performance in the aircraft can be predicted with some certainty based on his performance in the simulator. It is not an effective training strategy to take a student to the aircraft until he has attained proficiency in most or all tasks in the simulator. These findings augur well for the development of prescriptive training strategies. A course of instruction can be tailored to the student having trouble in the simulator that will enhance his ability to benefit from training in the aircraft.

FRS PERFORMANCE AS A PREDICTOR OF PERFORMANCE IN OPERATIONAL ASSIGNMENTS

To obtain feedback on the efficacy of FRS training, judgements were sought from fleet squadrons on the operational performance of assigned VP-30 trained pilots. Questionnaires were submitted to 17 operational squadrons requesting information on the performance of students who had participated in the earlier TAEG studies as either control or experimental subjects. Figure 4 contains sample items from the 42 item questionnaire.

The responses of 36 respondents to the questionnaire were analyzed and the results are presented in table 16.

INSTRUCTIONS FOR COMPLETING RATING SCALES

Listed below are tasks which presently receive at least some emphasis in training at VP-30. Please rate each task on the scale at the right by circling the most appropriate number. <u>Please feel free to also include your reasons for your rating and/or any specific recommendations for training on this task</u>. Your comments may be written in any available space on the front or back of this page or on a separate sheet.	ADEQUACY OF VP-30 TRAINING FOR THIS TASK 1. Task requires <u>much</u> more emphasis. 2. Training <u>less than adequate</u> for task, increase emphasis. 3. Training <u>adequate</u> for task. 4. Training <u>more than adequate</u> for task, reduce emphasis. 5. Greatly <u>reduce or eliminate</u> task.				
11. Perform appropriate procedures for EFAR	1	2	3	4	5
12. Control aircraft during takeoff with loss of an engine after refusal	1	2	3	4	5
13. Control aircraft during instrument departure	1	2	3	4	5
14. Determine position using TACAN/VOR/ADF	1	2	3	4	5
15. Visualize geographic orientation during instrument flight	1	2	3	4	5

Figure 4. Sample Questions from Followup Questionnaire

TABLE 16. SQUADRON JUDGMENTS OF VP-30 FRS CURRICULUM BASED ON STUDENT PERFORMANCE

	GROUPS									
	CONTROL					EXPERIMENTAL				
Rating Scale	1	2	3	4	5	1	2	3	4	5
Number of Judgments	11	142	637	31	1	7	133	507	15	-

A 5-point rating scale was used:

1 = Task requires much more emphasis
2 = Training less than adequate for task
3 = Training adequate for task
4 = Training more than adequate for task
5 = Greatly reduce or eliminate task

The modal response for the control and experimental groups was category 3 (Training Adequate) of the rating scale. This indicates general satisfaction with the VP-30 training program. More importantly, however, was the finding of no difference in the control students who received 15.1 flight hours and experimental students who received 8.6 flight hours ($\chi^2/3df = 5.73$). In addition to the overall performance, the groups were also compared on instrument tasks and landings. The comparisons produced no significant differences ($\chi^2/2df = 4.22$ for instrument tasks and $\chi^2/2df = .86$ for landings). There were too few responses for other tasks to make valid comparisons.

PERFORMANCE PREDICTORS

Applicants for Navy and Marine Corps pilot training are given various selection tests; among these are the Aviation Qualification Test (AQT) and the Flight Aptitude Rating (FAR). Scores on these tests along with various physical and educational criteria are used in the selection of potential candidates for pilot training. Since data were available the opportunity presented itself for a "quick look" at the relationships between the AQT, FAR, and performance in UPT and FRS. Correlations were computed on these variables with a sample of 65 students. The results are presented in table 17.

No significant correlations were found for any of the combinations examined. Based on this sample, the AQT and FAR scores were not useful predictors of FRS performance. This finding is consistent with findings reported by North and Griffin.[12]

[12] R. A. North and G. R. Griffin. Aviator Selection 1919 - 1977. Special Report 77-2. 1977. (Naval Aerospace Medical Research Laboratory, Pensacola, Florida) p. 28.

TABLE 17. CORRELATION OF AQT AND FAR TO UPT AND FRS PERFORMANCE

	r_{xy}	Multiple *r*
FAR vs. AQT	.22	
FAR vs. UPT Flight Average (Basic and Advanced Flight Scores)	.21	
AQT vs. UPT Flight Average	.15	
FAR vs. FRS Flight Average	.009	
AQT vs. FRS Flight Average	.11	
FAR and AQT vs. UPT Flight Average		.23
FAR and AQT vs. FRS Flight Average		.11

SUMMMARY OF FINDINGS

The findings discussed in this section are summarized below.

1. An inverse relationship was found between UPT flight averages and UPT flying hours and between FRS flight averages and UPT flying hours (the greater the number of UPT flight hours, the lower the UPT and FRS flight averages).

2. Students completing UPT with a combination basic and advanced flight score of less than 50 will generally be expected to require more flight hours to complete the FAM/INST phase of FRS than those students with UPT scores of greater than 50.

3. Based on the UBAA grades assigned, the performance of first-tour students in Device 2F87F, particularly for instrument tasks, is predictive of subsequent performance in the P-3 aircraft (see table 15).

4. Questionnaires distributed to 17 Fleet squadrons indicated no significant difference between experimental and control students after leaving VP-30 in (1) overall performance, (2) instrument proficiency, and (3) landing proficiency.

5. Based on the limited sample examined (N=65), AQT and FAR scores were not significantly correlated (at the .05 level) with performance at VP-30 and are not considered as predictors of performance at the FRS level.

SECTION V

CONCLUSIONS AND RECOMMENDATIONS

This section presents sets of general and specific conclusions from the study. For each specific conclusion, a course of action is recommended appropriate to the finding.

GENERAL CONCLUSIONS

1. The TAEG P-3 studies have demonstrated the feasibility of onsite assessment of the contributions of new synthetic devices in producing aviators for the fleet. In this case, the newly installed Device 2F87F is being efficiently integrated into the ongoing VP-30 training system without interrupting or delaying the pilot production commitments. It is recommended that each new major device undergo formal assessment concurrent with its introduction to insure effective integration into an ongoing training program.

2. To maintain the effective integration of a new device into an ongoing training program, certain controls are required. Among these are:

a. effective employment of training assets that matches media capabilities to training task requirements; i.e., CFT and CPT for part-task training and the apportionment of OFT and aircraft for complex whole task training,

b. standardization of instructional practices and grading criteria,

c. instructor training in the capabilities of synthetic trainers and effective integration of training devices into the training continuum,

d. heightened awareness of precise management control requirements and the special preparations needed for efficiency in training.

3. In support of the effort of integrating Device 2F87F into the P-3 curriculum, additional studies are needed to maximize the effectiveness of training. Foremost among these are:

a. develop performance standards and an automated performance measurement system,

b. determine precisely the optimum mix of simulator and aircraft training to achieve FRS FAM/INST qualification. To achieve this, emphasis should be placed on determining the training trials required as a function of student past performance in UPT.

The present study has shown that device effectiveness is in part dependent on the abilities of the student being trained. An effective training strategy should match training trials or periods of training with student abilities. For example, six simulator periods may be required to achieve proficiency for some students, but six periods may be inadequate for other students, particularly those coming from UPT with lower flight scores.

SPECIFIC CONCLUSIONS AND RECOMMENDATIONS

CONCLUSION	RECOMMENDATION
Due to the material condition and utilization practices employed with Device 2F69D, it was not significantly contributing to the training of dynamic flight tasks immediately prior to and after acceptance of the first Device 2F87F. This device has become a procedures trainer.	The device should be restored to its designed capability. Past evidence has shown that the device provides excellent training. Effective utilization of the 2F69D could relieve some of the pressure on 2F87F utilization.
A review of the Training Device Systems Summary Report, Level 1 (Report No. DMMQ10L01)[13] for Device 2F87F Serial Nos. 1 and 4 indicated an unusually high number of failures during the period covered by the report.	Both 2F87Fs should be checked by designated qualified pilots on a regular basis to insure maintenance of simulation and consistency of performance between the two devices. Further, the quality of maintenance should be improved to assure availability of all systems for every training period. Vigorous action is essential to prevent the 2F87F from being utilized essentially as a procedures trainer.
First-tour students with average UPT basic and advanced flight scores of 55 can complete the Familiarization/Instrument phase of FRS in an average of 15 flight hours in the P-3 without any training in an OFT.	Fifteen flight hours should be used as a basis for scheduling when the simulator is unavailable for training due to maintenance or modification.
Comparison of the performance of the experimental group trained in Device 2F87F and the P-3 with performance of the experimental group trained in the P-3 <u>without</u> 2F87F training has demonstrated the Device 2F87F can substitute for 6.5 hours of P-3 training. The performance of the operational (O) group and students subsequently trained has shown that the average training time is increasing. It is concluded that this gradual increase in flight hours will continue unless positive and aggressive action is taken.	Provide more comprehensive training for all new instructors in effective utilization of Device 2F87F. Schedule each new instructor to observe an experienced instructor for at least one class before being allowed to train students in the simulator or aircraft. Establish grading criteria based on defined standards of performance and require adherence to these criteria.

[13] Published by Code N-434, Naval Training Equipment Center, Orlando, FL.

CONCLUSION	RECOMMENDATION
The performance data of this study strengthens and supports earlier findings that landing practice in Device 2F87F transfers positively to the aircraft.	Disseminate this information to all instructors to ensure development of more positive attitudes toward the simulator.
Students trained to proficiency on tasks in the simulator have a higher probability of performing the task to proficiency on the first and succeeding flights in the aircraft.	Students should not be scheduled in the aircraft until proficiency has been attained in the task planned for training in the aircraft. Seek to return to block training in the simulator with a requirement that all tasks be trained to proficiency in the simulator prior to any aircraft training.
Performance in Device 2F87F is significantly correlated with later performance in the P-3.	Use a prescriptive approach to training. For the student experiencing trouble in the simulator, emphasize training that will correct deficiencies. Extend simulator training if necessary.
Students who have not demonstrated proficiency on all tasks are being recommended for Fly 4 checks. Some then require a second or third refly of the Fly 4 check.	For students not proficient at the end of Fly 3, schedule a Fly 4 and Fly 5, if necessary, instead of a check flight for which they are not prepared.
Concern over students coming to the FRS with fewer flight hours than the historical average is unfounded based solely on UPT flight hours. The study results indicate an inverse relationship between UPT pilot hours and UPT flight grades.	Analyze each incoming student's UPT performance record and prescribe a syllabus based on expected accomplishment.
UPT basic and advanced flight scores are valid predictors of performance at VP-30. Incoming students with a UPT flight score of less than 50 can, on the average, be expected to require more flight time at VP-30 and to finish with scores lower than the 3.03 average established at VP-30 over a number of years.	Develop a FAM/INST curriculum that will provide training that can accommodate differing learning rates of students.

GLOSSARY

ADF	Automatic Direction Finding
AIRCND/PRSR	Airconditioner/Pressurization
AQT	Aviation Qualification Test
BASIC ARWK	Basic Airwork
CFT	Cockpit Familiarization Trainer
COPILOT RESP	Copilot Responsibilities
CPT	Cockpit Procedures Trainer
EFAR	Engine Failure After Refusal
ELECT SYS OP	Electrical System Operation
EMERG DESCENT	Emergency Descent
EMERG SHTWN	Emergency Shutdown
ENG RSTRT	Engine Restart
FAM/INST	Familiarization/Instrument
FAR	Flight Aptitude Rating
FIRE UNK ORIG	Fire of Unknown Origin
FRS	Fleet Readiness Squadron
FUEL SYS OP	Fuel System Operation
GCA	Ground Controlled Approach
HYD SYS OP	Hydraulic System Operation
ILS	Instrument Landing System
INST PROCEDURES	Instrument Procedures
KNWLG PROCEDURES	Knowledge of Procedures
LANDING PTRN AIRWK	Landing Pattern Airwork
LOC	Localizer Approach
LOITER SHTWN	Loiter Shutdown
MISSED APP	Missed Approach
NAV INST FAIL	Navigation Instrument Failure
NDB	Non-directional Beacon
NON PREC APP	Non-precision Approach
NTS	Negative Torque Sensing
OFT	Operational Flight Trainer
P	Proficiency
P-3	Lockheed Orion Aircraft
PROP/ENG MALF	Propeller/Engine Malfunction
RES ELECT PWR	Restoring Electrical Power
TACAN	Tactical Air Navigation
TAEG	Training Analysis and Evaluation Group
TER	Transfer Effectiveness Ratio
UPT	Undergraduate Pilot Training
VOR	Very High Frequency Omnidirectional Range
VP-30	Patrol Squadron THIRTY

DISTRIBUTION LIST

Air Force

Headquarters, Air Training Command (XPTD, Dr. D. E. Meyer)
Air Force Human Resources Laboratory, Brooks Air Force Base
Air Force Human Resources Laboratory (Library), Lowry Air Force Base
Air Force Office of Scientific Research (Dr. A. R. Fregly)
HQ ATC/XPTIA (Mr. Goldman), Randolph Air Force Base
Air Force Human Resources Laboratory (ASR/B, B. Cream), Wright-Patterson Air Force Base

Army

Army Research Institute (Dr. Ralph R. Canter, 316C; Dr. Edgar Johnson; Dr. H. F. O'Neil, Jr.)
Commander TRADOC (Technical Library)
Commander U.S. Army Aviation Center (ATZQ-D-SQ), Ft. Rucker, AL
Army Research Institute, Fort Rucker, AL

Coast Guard

U.S. Coast Guard Aviation Training Center (Kingsley Povenmire)

Marine Corps

CG MCDEC (Mr. Greenup)
Director, Marine Corps Institute

Navy

OASN (R&D) (Dr. S. Koslov)
OASN (MRA&L) (Dr. B. D. Rostker)
DASN (M) (Miss M. Snavely)
OASN (MRA&L) (Mr. W. H. Lindahl)
CNO (OP-987P7, CAPT H. J. Connery; OP-991B, M. Malehorn; OP-987P10, Dr. R. Smith; OP-987, H. Stone; OP-596; OP-596; OP-594B)
COMNAVAIRSYSCOM (Code 03, 340F, 413, PMA-240 (CAPT Petri))
CNM (MAT-03424, Mr. A. L. Rubinstein)
ONR (Code 458, 455)
ONRBO Boston (J. Lester)
ONRBO Chicago
ONRBO Pasadena (E. E. Gloye)
CNET (01, 00A, N-4, N-5 (5 copies))
CO NAVEDTRAPRODEVCEN (AH3)
CNET SUPPORT (00, 00A (2 copies))
CNTECHTRA (0161, Dr. Kerr (6 copies))
CNATRA (F. Schufletowski)
CNAVRES (Code 02)
COMTRALANT
COMTRALANT (Educational Advisor)
COMTRAPAC

DISTRIBUTION LIST (continued)

CO NAVEDTRASUPPCEN NORVA
CO NAVEDTRASUPPCENPAC
CO NAVPERSRANDCEN (Library (4 copies))
NAVPERSRANDCEN Liaison (Code 01H)
NAMRL (Chief Aviation Psych. Div.)
U.S. Naval Institute (CDR Bowler)
NAVPGSCOL (Code 2124)
U.S. Naval Academy (Chairman, Behavioral Science Dept.)
CO NAVTRAEQUIPCEN (N-424 (2 copies), N-OOAF, N-OOM, N-211, N-71)
Center for Naval Analyses (2 copies)
CO VP 30 (3 copies)
CO VP 31 (3 copies)
COMPATWINGLANT (3 copies)
COMPATWINGPAC (3 copies)
COMNAVAIRLANT (Code 35)
COMNAVAIRPAC (Code 31)
OIC FASOTRAGRULANT DET JACKSONVILLE
Navy Liaison Office, Air Force Human Resources Laboratory, Flight Training Division (Captain W. Mercer), Williams AFB
COMPATWING FIVE
COMPATWING ELEVEN

Other DOD

Military Assistant for Human Resources, OAD (E&LS) ODDR&E (LTCOL Henry Taylor)
OASD (MRA&L) (LTCOL Grossel)
Director, Human Resources Office, ARPA (R. Young)
Institute for Defense Analyses (Dr. Jesse Orlansky)

Non-DOD

Essex Corporation (Dr. John Collins)
FAA, Washington, D.C. (Mr. Howse)

Information Exchanges

DDC (12 copies)
DLSIE (James Dowling)
Executive Editor, Psychological Abstracts, American Psychological Association
ERIC Processing and Reference Facility, Bethesda, MD (2 copies)